United States Patent [19]

Cresk ff

[11] **3,833,251**

[45] **Sept. 3, 1974**

[54] **LONGITUDINALLY STIFFENED FLEXIBLE LIFTER FOR ARCUATE OBJECTS**

[75] Inventor: **Jacob J. Creskoff**, Wynnewood, Pa.

[73] Assignee: **Aerovac Corporation**, Bala-Cynwyd, Pa.

[22] Filed: **Oct. 6, 1972**

[21] Appl. No.: **295,634**

[52] **U.S. Cl.** ..... **294/64 R**, 294/65

[51] **Int. Cl.** **B66c 1/02**

[58] **Field of Search**..... 294/64 R, 65; 214/650 SG, 214/8.5 D; 248/206, 362, 363

[56] **References Cited**

UNITED STATES PATENTS

3,260,391	7/1966	Horton	294/65 X
3,367,705	2/1968	Ames	294/64 R
3,610,672	10/1971	Olson	294/65

Primary Examiner—Evon C. Blunk
Assistant Examiner—Johnny D. Cherry
Attorney, Agent, or Firm—Caesar, Rivise, Bernstein & Cohen

[57] **ABSTRACT**

A vacuum lifter is provided for arcuately shaped objects which includes a flexible sheet having opposed parallel surfaces. A supporting member is connected to one surface of the sheet and a resilient sealing gasket is connected to the opposing surface of the sheet about the periphery thereof. A source of vacuum is provided and the sheet has a port through which the vacuum source communicates. Stiffening means are connected to the flexible sheet to prevent bending of the sheet about a line extending at an angle transverse to the longitudinal extent of the plate. The lifter is secured to an arcuate object by placing the gasket against the outer surface of the object so that a partial vacuum is formed in the compartment formed between the outer surface of the object, the sheet and the gasket. The sheet accomodates a range of diameters of arcuate objects by bending around its longitudinal axis to conform to the diameter of the objects.

7 Claims, 5 Drawing Figures

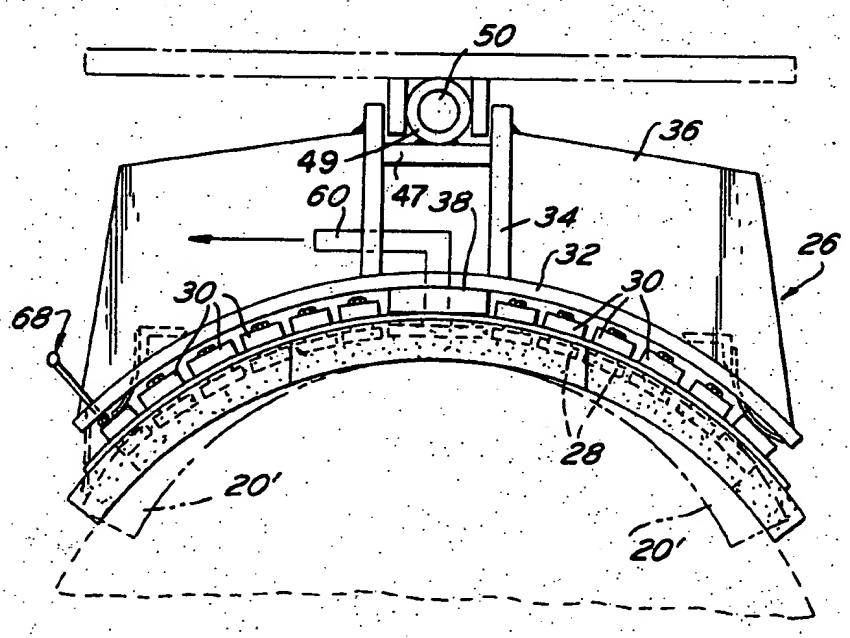

FIG. 1

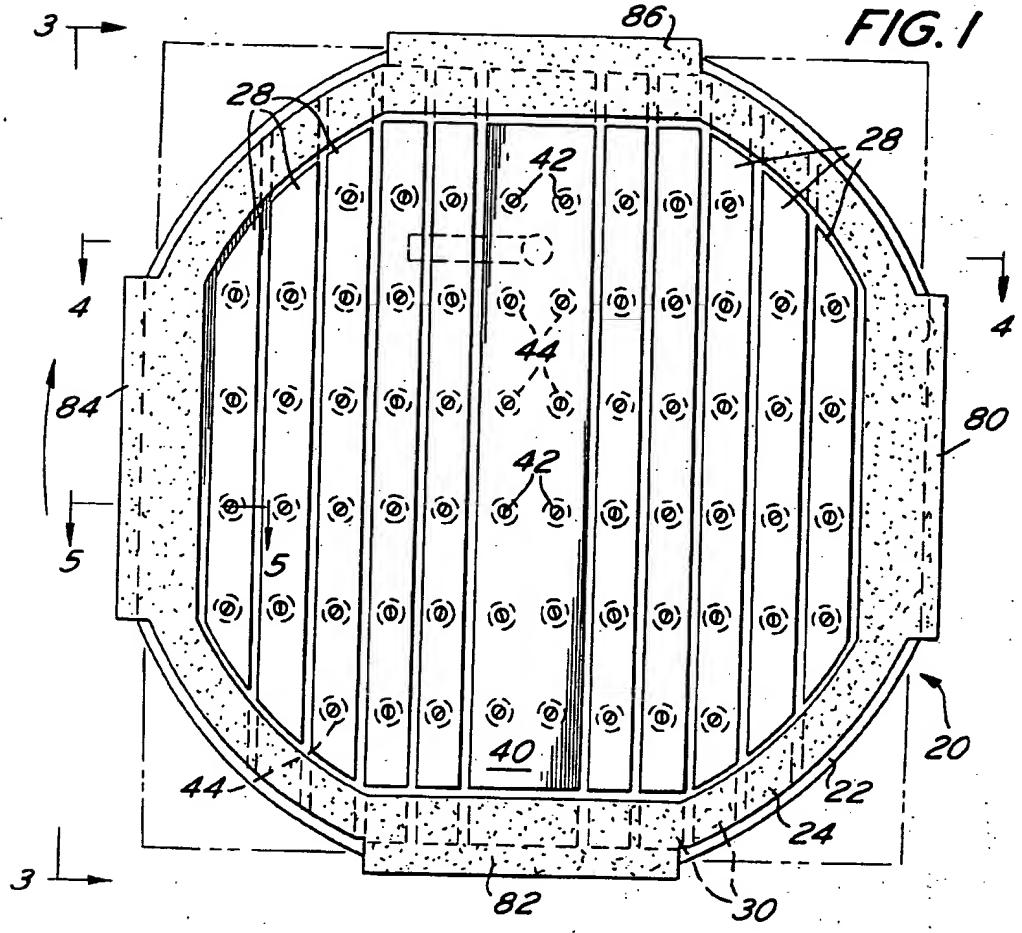
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FIG. 2

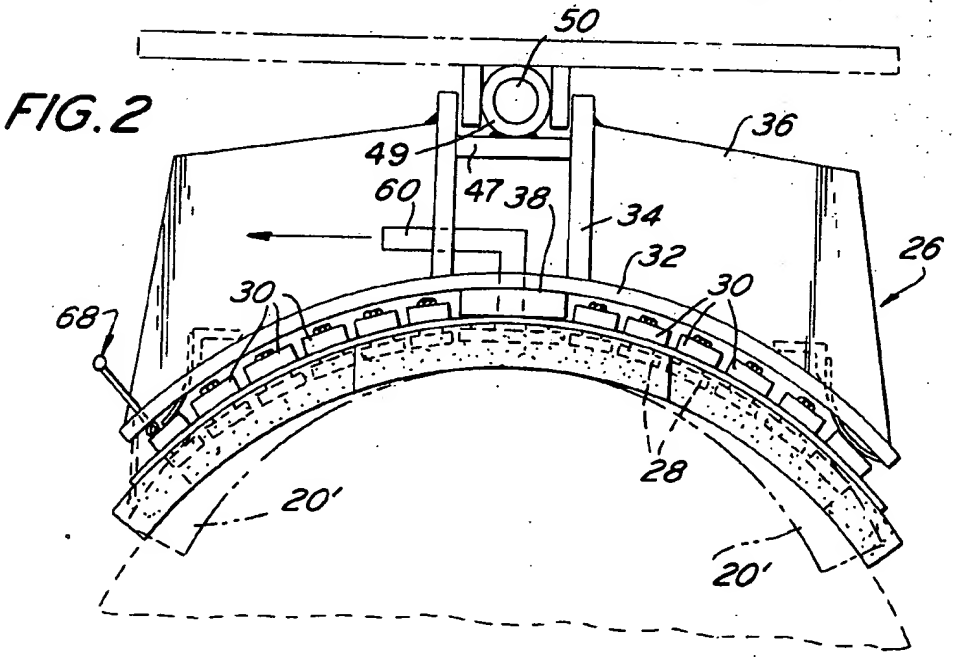
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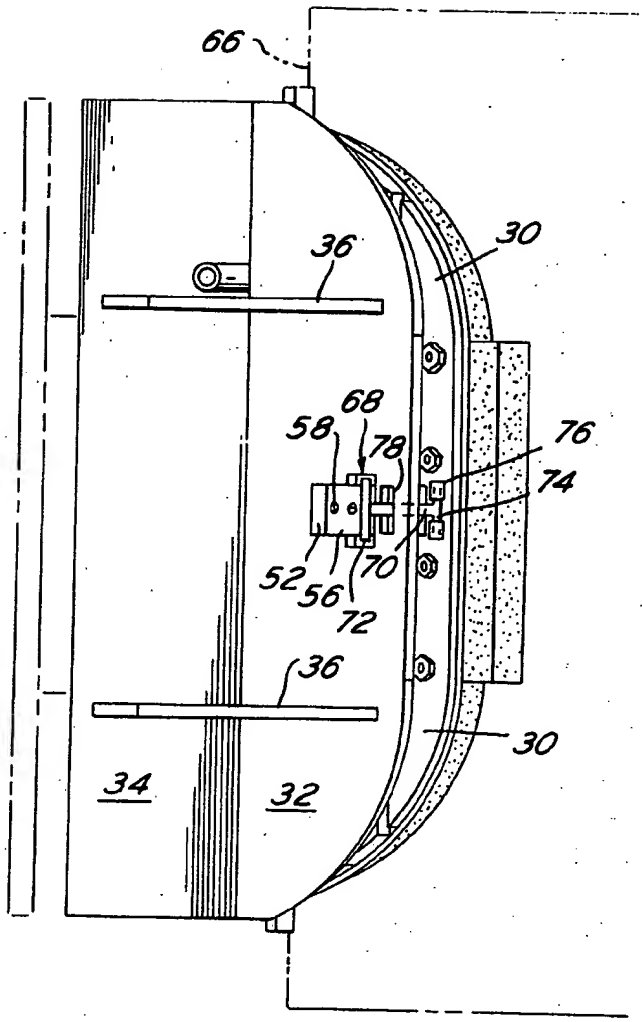
FIG. 3



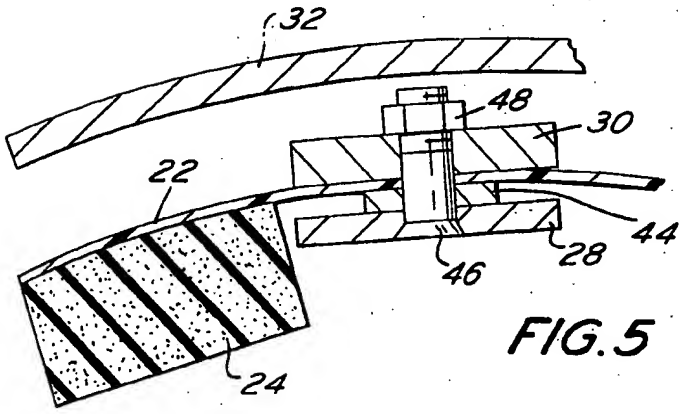


FIG. 5

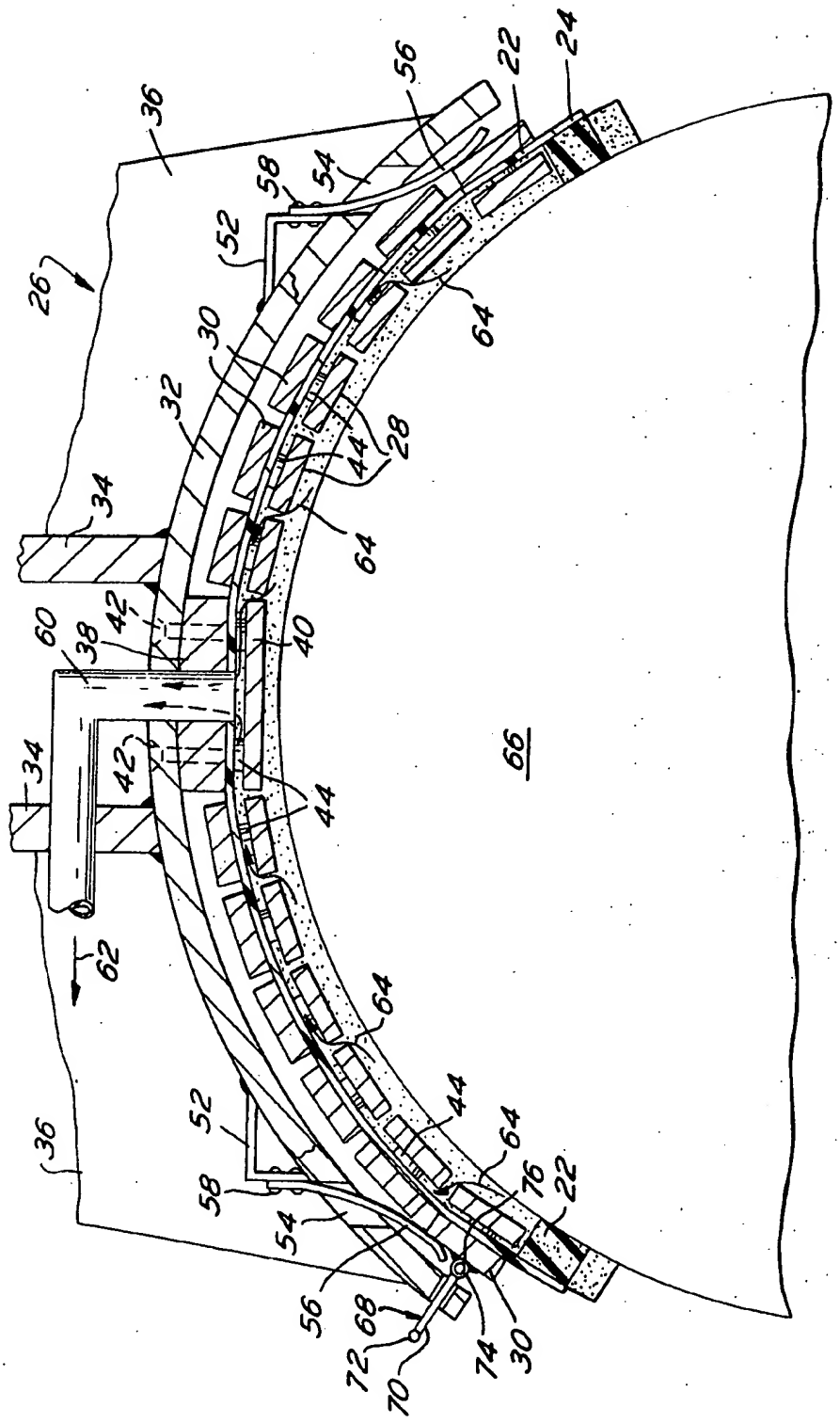

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FIG. 4

LONGITUDINALLY STIFFENED FLEXIBLE LIFTER FOR ARCUATE OBJECTS

This invention relates generally to vacuum lifters and more particularly to a flexible lifter which is longitudinally stiffened to enable its use for cylindrical or arcuate objects such as newsprint rolls.

One of the most difficult handling problems for stevedores in loading and unloading cargo ships, trailers and other formes of conveyance are newsprint rolls which are generally in a weight range of 1,000 pounds to 3,000 pounds and are cylindrically shaped having a diameter ranging from approximately 36 inches to 44 inches. At present, newsprint rolls are normally loaded and unloaded by use of fork lift trucks having clamping devices which embrace the newspaper roll and are then clamped tightly against the outer surface to frictionally engage the roll while lifting the roll and moving it from one place to another. In order to frictionally engage the newsprint roll the clamping surfaces are of necessity abrasive to permit slippage of the newsprint roll when the roll is lifted and lowered. The lifting and lowering stresses as well as the abrasive surface of the lifters often causes damage to the newsprint roll. In addition, unless the roll is standing on one of its planar edges, it is difficult for the clamping device to get underneath the roll in order to embrace and carry the roll.

It is therefore an object of the invention to overcome the aforementioned disadvantages of the prior lifting devices.

Another object of the invention is to provide a new and improved lifting attachment for use on fork lifting trucks which will enable newsprint rolls to be easily handled and which will withstand the operational shocks and prevent damage to the newsprint rolls.

Yet another object of the invention is to provide a new and improved lifting attachement for use on fork lift trucks which will facilitate the handling of newprint rolls whether the newsprint roll is standing on its planar or cylindrical surface.

Still another object of the invention is to provide a new and improved flexible lifter which is stiffened longitudinally to enable securement of the flexible lifter to the object to be lifted from a lateral disposition.

Still another object of the invention is to provide a new and improved flexible lifter attachment which can be utilized by fork lift trucks and other conveyance devices which are secured to an object from a lateral position.

These an other objects of the invention are achieved by providing a new and improved vacuum lifter for arcuately shaped objects which comprises a flexible sheet having opposed parallel surfaces.

The sheet has a supporting member connected to one surface of the sheet and a resilient gasket connected to the opposing surface of the sheet about its periphery thereof. A source of vacuum is provided which is connected through a port in the sheet. A stiffening means is provided which is connected to the flexible sheet to prevent bending of the sheet about a line extending at an angle transverse to the longitudinal extent of the sheet. The lifter is secured to an arcuate object by placing the gasket against the outer surface of the object so that a partial vacuum is formed in the compartment formed between the outer surface of the object, the sheet and the gasket. The sheet accomodates a range of diameters of arcuate objects by bending around the longitudinal axis to conform to the diameter of the object.

Other objects and many of the attendant advantages of this inventi n will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein;

FIG. 1 is a front elevational view facing the gasket side of the vacuum lifter;

FIG. 2 is a top plan view of the lifter;

FIG. 3 is a side elevational view of the lifter;

FIG. 4 is an enlarged sectional view taken along the line 4—4 in FIG. 1; and

FIG. 5 is an enlarged fragmentary sectional view taken along the line 5—5 in FIG. 1.

Referring now in greater detail to the various figures of the drawing wherein like reference numerals refer to like parts, a flexible vacuum lifter embodying the invention is shown generally at **20** in FIG. **1**.

As seen therein, the flexible lifter **20** basically comprises a flexible sheet **22** having a pair of opposed parallel surfaces a sealing gasket **24**, a supporting member **26** (FIG. 2) and longitudinal stiffening means comprising a plurality of narrow longitudinally extending plates **28** connected to the front surface of sheet **22** and similar plates **30** connected to the rear surface of the sheet **22**.

The sealing gasket **24** is connected about the periphery of the front surface of the sheet **22** and is preferably comprised of a resilient deformable closed cell material such as neoprene. The flexible sheet **22** preferably comprises a thin sheet of polyurethane but may also be formed of other suitable high tensile strength flexible materials such as neoprene or metal.

The supporting member **26** as best seen in FIG. **4** basically comprises a cylindrically arcuate supporting plate **32**, a pair of transversely extending lifting bars **34**, which are suitably welded to the supporting plate **32**, and a plurality of integrally formed planar ribs **36** which extend transversely to the plane of arcuate lifting plate **32** and lifting bars **34**. A supporting bar **38** is interposed between the supporting plate **32** and the flexible sheet **22**. A similar supporting bar **40** disposed adjacent the front surface of the flexible sheet aligned with the supporting bar **38** and centrally of the flexible sheet **22** is also provided. A plurality of suitable fastening elements **42** extend through the supporting plate **32**, supporting bars **38**, sheet **22** and bar **40** to secure a sheet to the supporting member **26**.

As best seen in FIG. **1**, the stiffening plates **28** extend longitudinally of the flexible lifter and are transversely spaced along the transverse extent of the front surface of the sheet **22**. As best seen in FIG. **2**, the longitudinally extending plates **30** extend parallel to and are aligned with corresponding plates **28** on the opposing surface of sheet **22**. The plates **30** also extend longitudinally and parallel to a supporting bar **38**.

As best seen in FIG. **5**, each of the plates **28** includes a plurality of washers **44** which are spaced along the length of the plate **29**. Each of the washers **44** are preferably welded to the plates **28** and are aligned with an opening through which a suitable threaded fastener **46** extends. A similar plurality of openings are provided in plate **30** which are aligned with plates **28** so that fastener **46** can be telescoped through the plate **28**, the washer **44**, the plate **30** and then suitable secured to a nut **48** on the opposite side of plate **30**. The head of the

fastener 46 is preferably countersunk so that the front surfaces of plates 28 are completely flush and do not provide an abrasive surface which can abut the newsprint rolls.

Referring to FIG. 2, it should be noted that supporting member 26 further includes a bridging plate 47 which is integrally connected between lifting bars 34 and is integrally welded to a collar 49 which is journalled over a lifting pin 50 of a fork lift truck (not shown).

The support mechanism for supporting the lifter 20 is shown in phantom in FIGS. 1 and 2. The supporting mechanism is preferably of the type that rotates 90° about the horizontal axis extending longitudinally of the truck and centrally through the center of the support mechanism. The support mechanism of the truck may also rotate 360° about the same axis.

As best seen in FIG. 4 a pair of L-shaped brackets 52 are secured to the rear of the support plate 32 preferably by welding. The brackets 52 are mounted adjacent a pair of longitudinally extending slots 54 which extend through the supporting plate 32. Both of the brackets 52 support a leaf spring 56 which extend through openings 54 and are secured to the brackets 52 by suitable fasteners 58. The leaf springs 56 act to urge the flexible lifter to its smallest diameter which is shown in phantom at 20' in FIG. 2.

Referring to FIG. 4, it can be seen that plates 40, 38 and 32 as well as the sheet 22 includes an opening through which one leg of an L-shaped pipe 60 extends. Pipe 60 is connected to a suitable source of vacuum as indicated by arrow 62 in FIG. 4. The preferred source of vacuum is reservoir tank which is in turn connected to a suitable vacuum pump.

The plates 28 which act as stiffening members also act in combination with washers 44 to distribute the vacuum uniformly through the entire front surface area of the flexible lifter 20. That is, the washers 44 space the major portion of plates 28 from the front surface of sheet 22. Accordingly, as is indicated by arrows 64 in FIG. 4, air can readily pass beneath the plates 28 past the washers 44 even when the resilient gasket 24 is deformed so that the plates 28 rest against the outer surface of an object being lifted.

As best seen in FIG. 4, a suitable cylindrical object such as a newsprint roll 66 can be secured to the lifter 20 by disposing the gasket 24 against the outer periphery of the roll 66. Suitable valves are then opened to connect the port provided in the sheet 22 by pipe 60 to the source of vacuum and thereby cause a reduced pressure within the compartment formed between the outer surface of the roll 66, the gasket 24, and the front surface of sheet 22. Once the gasket 24 has been properly seated, a partial vacuum is formed very quickly within this compartment and thereby enables the flexible lifter to be so secured to the roll 66 as to easily enable the lifting of the newsprint roll 66.

As best seen in FIGS. 3 and 4, a limiting member 68 is provided on the leftmost (as seen in FIG. 4) stiffening plate 30 of the flexible lifter. The limiting member 68 basically comprises a pin 70 having a pair of transversely extending end pins 72 and 74 which are integrally secured at the ends of pin 70. Pin 70 is connected centrally of the end pins 72 and 74.

The end pin 74 is suitably journalled in a pair of annular collars 76 which are preferably welded to plate 30. Pin 70 extends through a slot 78 in the plate 32. The pin 70 is thus pivotable around an axis through pin 74 which is journalled in collars 76. The maximum separation of the plate 30 from plate 32 is limited by pin 72 which abuts the rear surface of plate 32 when plate 30 is moved with the flexible lifter 20 to the position shown in phantom at 20' in FIG. 2. The limiting member 68 is provided so that the flexible lifter 20 may be used not only as shown in FIGS. 1 through 5 where the longitudinal plates 28 and 30 extend vertically but also when the lift truck rotates the flexible lifter to a position where the longitudinal plates 28 and 30 extend horizontally.

When the plates 28 and 30 extend horizontally, the limiting member 68 is at the uppermost end of the flexible lifter and prevents the weight of plates 28 and 30 from causing the upper portion of the flexible sheet to be bent to a diameter which is too small to fit over a cylindrical object. That is, the weight of the plates could cause the flexible sheet to curl over which prevents the gasket from being properly seated without the limiting member 68.

As best seen in FIG. 1, the sealing gasket 24 has four enlarged portions 80, 82, 84 and 86. The portions 80, 82, 84 and 86 which extend outwardly of the periphery of the remaining portion of the gasket 24 are not adhesively secured to the front surface of the sheet 22 as is the remaining portion of the gasket. The enlarged portions 80, 82, 84 and 86 are provided where the vacuum lifter 20 can be rotated 360° about an axis extending horizontally and transversely to the center plate 40. In most lift trucks where there is only 90° of rotation, only two enlarged portions of the gasket need be provided. For example, in FIG. 1 only portions 84 and 86 would be required since these would be the portions of the gasket which are in the uppermost position when the flexible lifter is seated against the outer surface of an object to be lifted.

The enlarged portions of the gasket are therefore provided because as the arcuate object is picked up off the ground, the maximum unseating stress comes at the uppermost portion of the gasket and the extra portion of the gasket acts to prevent the unseating at its most vulnerable spot.

It can therefore be seen that a new and improved flexible lifter has been provided for lifting arcuate objects. The stiffening members comprised of plates 28 and 30 act to enable the flexible sheet 22 to be arcuately bent only about a longitudinally extending line. Similarly, the stiffening members prevent the bending of the flexible sheet about a line transverse to the longitudinal extent of the lifter.

In operation the flexible lifter 20 is used in combination with a truck having a supporting system which is capable of raising and lowering as well as rotating the flexible lifter 20. In its typical utilization the flexible lifter is urged laterally towards an object which is to be lifted and as soon as the gasket is substantially seated the source of vacuum is connected to the vacuum compartment formed between the gasket and the flexible sheet 22. As soon as the gasket is seated, the compartment is closed by the outermost surface of the object.

As set forth above, a newspaper roll may be attached to the flexible lifter when the roll is either in a vertical or horizontal position. When the roll is in a vertical position the flexible lifter is laterally moved to substantially the center of the roll and laterally engages the roll as set forth above.

Similarly, when the roll is on its side, the lifter **20** is rotated to a position 90° from the position shown in FIG. **1** and is lowered so that the lifter plate **40** is substantially aligned with the center of the roll. The lifter **20** is moved laterally towards the roll and as soon as the gasket is substantially aligned with the roll the source of vacuum is connected to the compartment formed between the gasket **24**, the outer surface of the roll and the front surface of sheet **22**. As soon as the partial vacuum is formed in this compartment, the newspaper roll can be lifted and transported as desired. To remove the roll from the lifter, a suitable valve is opened to restore atmosphere pressure to the lifter compartment.

Without further elaboration, the foregoing will so fully illustrate my invention that others may, by applying current or future knowledge, readily adapt the same for use under various conditions of service.

What is claimed as the invention is:

1. A vacuum lifter for arcuately shaped objects comprising a flexible sheet which is formed of a flexible material and has opposed parallel surfaces and a source of vacuum, said sheet having a port through which said vacuum source communicates, a supporting member connected to one surface of said sheet, a resilient sealing gasket connected to the opposing surface of said sheet about the periphery thereof, and stiffening means connected to said flexible sheet to prevent bending of said sheet about a line extending at an angle transverse to the longitudinal extent of said sheet, said stiffening means comprising a plurality of closely spaced longitudinally extending plates provided along the entire transverse extent of said flexible sheet, said lifter being secured to an arcuate object by placing said gasket against the outer surface of said object so that a partial vacuum is formed in the compartment formed between the outer surface of said object, said sheet and said gasket, said sheet accommodating a range of diameters of arcuate objects by bending around its longitudinal axis to conform to the diameter of said object.

2. The vacuum lifter of claim **1** wherein said closely spaced longitudinally extending plates are connected to the front and rear surfaces of the flexible sheet.

3. The vacuum lifter of claim **2** wherein the longitudinally extending plates connected to the side of said sheet that said gasket is connected each have spacing means connected between the plates and said sheet, said spacing means enabling a uniform distribution of the partial vacuum in the compartment formed between an object to be lifted, the gasket and said flexible sheet.

4. The vacuum lifter of claim **1** wherein said gasket includes an enlarged portion on one side of said lifter, said enlarged portion being provided on the uppermost edge of said lifter when said lifter engages an object to be lifted, said enlarged portion being integral with said gasket and movable with respect to said sheet so that said portion provides a fortified sealing area when said object is lifted.

5. A vacuum lifter for arcuately shaped objects comprising a flexible sheet having opposed parallel surfaces and a source of vacuum, said sheet having a port through which said vacuum source communicates, a supporting member connected to one surface of said sheet, a resilient sealing gasket connected to the opposing surface of said sheet about the periphery thereof, and stiffening means connected to said flexible sheet to prevent bending of said sheet about a line extending at an angle transverse to the longitudinal extent of said sheet, said lifter being secured to an arcuate object by placing said gasket against the outer surface of said object so that a partial vacuum is formed in the compartment formed between the outer surface of said object, said sheet and said gasket, said sheet accommodating a range of diameters of arcuate objects by bending around its longitudinal axis to conform to the diameter of said object, said supporting member including an arcuate plate which is connected centrally to said flexible sheet, said arcuate plate including means for urging the transverse ends of said lifter in an arcuate shape to facilitate seating of the gasket against an arcuate object.

6. The vacuum lifter of claim **5** wherein said means for urging includes a pair of leaf springs which extend through said arcuate plate and urge the outermost edges of said flexible sheet inwardly, said springs enabling said transverse ends of said lifter to be resiliently flexible when said edges engage an object to be lifted.

7. The vacuum lifter of claim **1** and further including limiting means provided on at least one of said transverse edges of said lifter, said limiting means acting to prevent more than a predetermined spacing between said flexible lifter and said support means.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Pat nt No. 3,833,251 Dated S ptember 3, 1974

Jacob J. Creskoff

It is certified that errors appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

(1) Column 1, line 21: "premit" should be -- prevent--.

(2) Column 2,line 60: "plate 29" should be-- plate 28--.

(3) Column 3,line 33: "is reservior" should be-- is a reservior--.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

ATTN.

408 736-3564

Sept. 9, 1969 W. K. MAMMEL 3,466,079

PRESSURIZED FLUID PICKUP DEVICE

Filed Sept. 8, 1965 2 Sheets-Sheet 1

FIG. 1

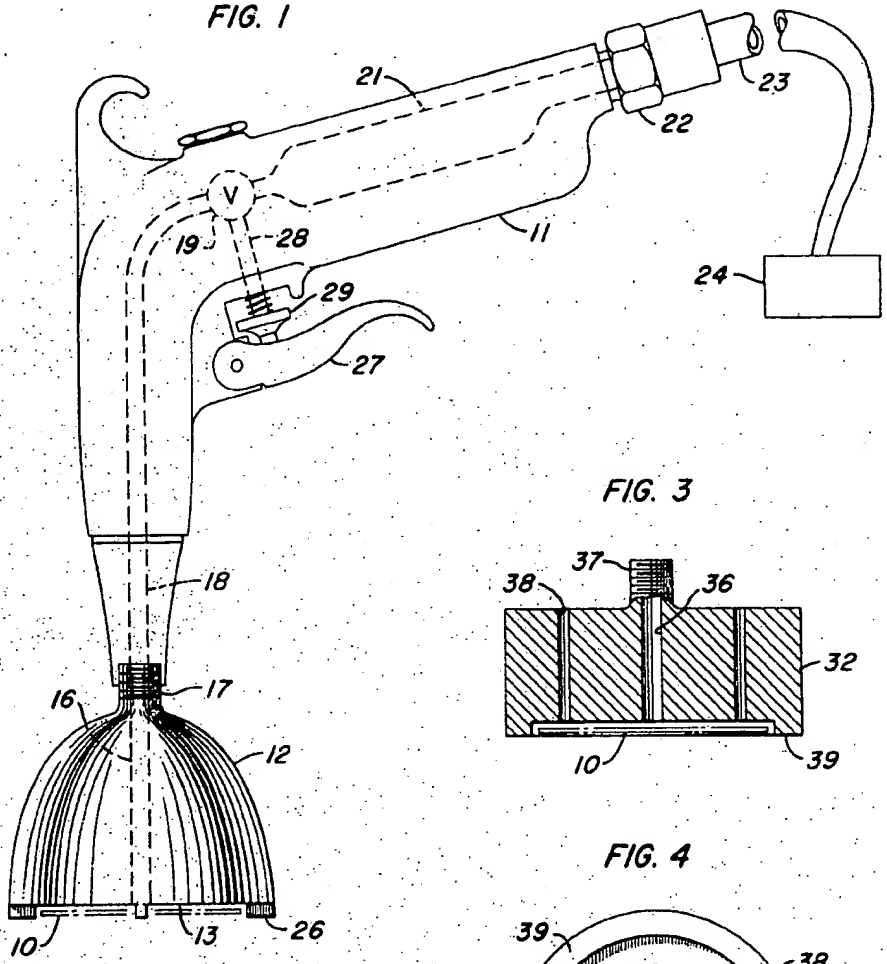


FIG. 3

FIG. 4

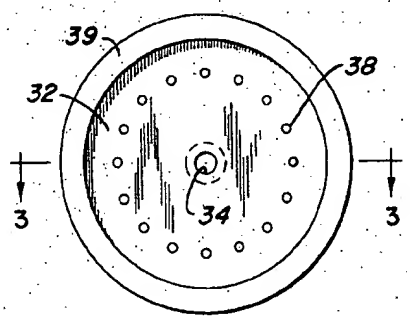
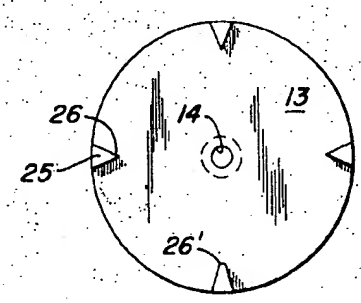


FIG. 2



INVENTOR
W. K. MAMMEL
BY R. P. Miller
ATTORNEY

Sept. 9, 1969 W. K. MAMMEL 3,466,079

PRESSURIZED FLUID PICKUP DEVICE

Filed Sept. 8, 1965 2 Sheets-Sheet 2

FIG. 5

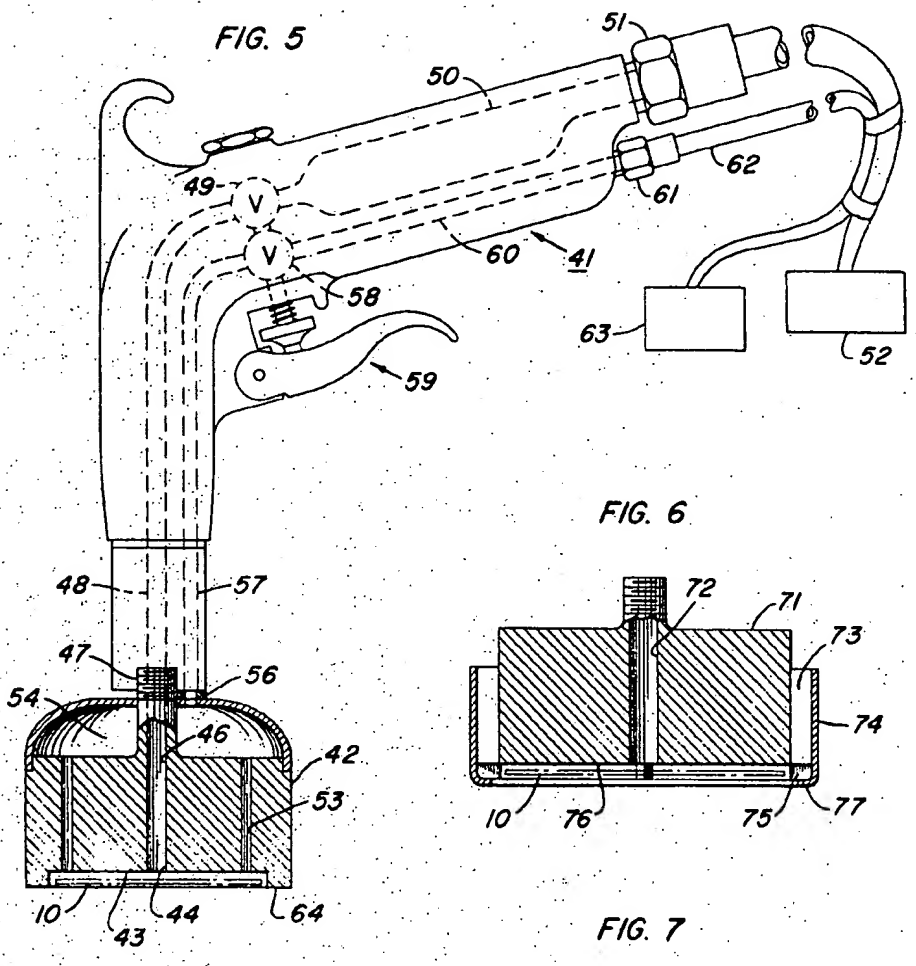
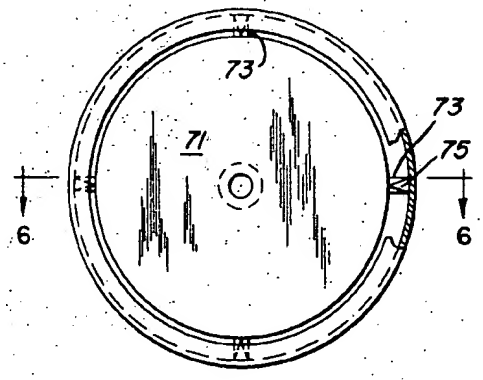


FIG. 6

FIG. 7



United States Patent Office 3,466,079 Patent d S pt. 9, 1969

3,466,079

PRESSURIZED FLUID PICKUP DEVICE

Walter K. Mammel, Yardley, Pa., assignor to Western Electric Company, Incorporated, New York, N.Y., a corporation of New York

Filed Sept. 8, 1965, Ser. No. 485,751
Int. Cl. B66c 1/02
U.S. Cl. 294—64 2 Claims

ABSTRACT OF THE DISCLOSURE

A pressurized fluid pickup device which consists of a head with a central orifice through which fluid under pressure is applied to a workpiece. Means are provided at the periphery of the head to direct fluid away from the work piece. The workpiece is maintained in a suspended condition spaced from the head as a result of the balance maintained between the weight of the workpiece, the atmospheric pressure and the sub-atmospheric pressure-produces by fluid passing across the face of the workpiece which is adjacent the head.

This invention relates to a pressurized fluid pickup device and more particularly to a readily manipulatable gun having facilities for picking up a thin slice of semiconductor or other material without physical contact and holding the slice in a spaced position.

In the fabrication of semiconductor devices such as transistors, thin circular slices of doped silicon or other materials are used to impart the semiconductor characteristics. The fabrication requires multi-processing and handling steps that must be performed with a minimum degree of contamination of the slices. At the same time, extreme care must be exercised to avoid scratching, fracturing, or chipping of the slice which is extremely brittle.

At present, various tweezers, vacuum pickup devices, and other clamping or gripping devices are being used. All of these devices result in physically gripping the slice, resulting in both a considerable amount of contamination and physical damage.

Further, in the processing of the slices, at least one surface must be treated, cleaned or etched to have a surface on which the semiconductor may be constructed. Various facilities are being used to swirl or orbit the slices in a cleaning solution to obtain maximum flow of solution across the surface to insure a resultant surface that is clean and free of ridges and/or grooves. Again, these facilities are subject to problems of physically gripping or holding the slices, thus subjecting them to damage and contamination.

An object of this invention resides in a new and improved pressurized fluid pickup device.

A further object of the invention is the provision of a portable pickup device utilizing either gaseous or liquid fluid for retaining a slice in spaced relation with the device during transport or processing of the slice.

An additional object of the invention is the provision of a pressure pickup device wherein fluid is passed across a surface of a semiconductor slice with sufficient velocity to hold the slice spaced from the device while the fluid also acts to clean, heat, dry, etch, and/or remove foreign particles or otherwise treat the surface of the slice.

Another object of the invention resides in applying pressurized fluid through and then laterally along a flat surface with sufficient velocity to hold an article spaced from the surface whereafter the laterally moving fluid is exited through an array of passageways spaced about the periphery of the surface.

A still further object of the devices is the provision of a pressure pickup devise with facilities for precluding or limiting lateral shifting of an article held by the device.

With these and other objects in view, the present invention contemplates a fluid pressure pickup and transport device wherein pressurized fluid is passed over an article to lift and hold the article suspended in spaced relationship to a reference surface on the device, and there are facilities on the surface for precluding or limiting lateral shifting of the article relative to the surface. More particularly, the device is in the form of a trigger-valve operated gun having a head with the reference surface formed thereon. Pressurized fluid is impressed through the gun to an exit port formed in the reference surface whereupon the fluid is impinged upon and laterally deflected over the article. There is a lift which is exerted on the article due to the reduced static pressure head in the fluid between the slice and the reference surface. As the article is lifted to close the gap between the article and the reference surface, there is an increase in the velocity head of the escaping pressurized fluid. The article will move toward the reference surface until there is a balancing of the total forces acting on both the top and bottom surfaces of the article.

Other objects and advantages of the present invention will be apparent from the following detailed description when considered with the accompanying drawings, wherein:

FIG. 1 is a side elevational view of a pressurized fluid pickup gun embodying the principles of the present invention;

FIG. 2 is a plan view of a pickup head of the gun shown in FIG. 1 in which there is illustrated stops for limiting lateral shifting of an article relative to the pickup head;

FIG. 3 is a cross-sectional view of an alternative embodiment of a pickup head having passageways to preclude the lateral escape of pressurized fluid;

FIG. 4 is a plan view of the face of the head shown in FIG. 3 particularly illustrating an array of passageways for receiving the escaping fluid;

FIG. 5 is a side elevational view of an additional embodiment of the invention showing vacuum means for collecting the escaping pressurized fluid;

FIG. 6 is a cross-sectional view of a further embodiment of the invention wherein the pickup head is provided with a fluid exit skirt; and

FIG. 7 is a plan view of the face of the head shown in FIG. 6 particularly illustrating the construction and muonting of the skirt.

Referring to FIGS. 1 and 2, there is shown an embodiment of the invention comprising a gun-like device for picking up a thin slice 10 of material, such as silicon. The silicon slice 10 has a surface which may be polished or etched or the surface may be coated with a photoresist. In the illustrated embodiments of the invention, the slice is shown as being in the shape of a disc, but it is contemplated that other shaped slices or articles may be picked up and transported. In handling these silicon slices, it is important that the surface be maintained free of scratches and contaminants, such as grease, dirt, or materials that might diffuse into the slice. The gun-like device is designed to pick up and hold the slice without actually making physical contact with either face.

The gun consists of a body or handle 11 connected to a head 12 having a flat surface 13 in which there is formed an exit orifice 14 of an air passageway 16. The passageway 16 terminates in a coupling 17 connected to a line or conduit 18 running through a conventional slide valve 19 to a further air line or conduit 21 terminating in a bushing 22. This bushing 22 enables a connection to be established between the air line 21 and an air hose

or conduit 23 running to a source 24 of compressed air or other pressurized fluid.

The head 12 is provided with a circumferential array of projecting lugs 25 which are tapered to a point 26 or to a rounded end 26' to prevent or limit shifting of the slice relative to the surface 13. The circumferential spacing of lugs 25 is less than the diameter or smallest diagonal dimension of the slice 10.

The head 12 may be constructed of quartz or other material that will not mar, contaminate, or tend to scratch the surface of the slice 10 or otherwise degrade the slice, if contact with the slice should be made during pickup, handling, or treatment of the slice. Further, the head may be constructed of transparent material which will permit the viewing of the top surface of the slice 10 during pick-up and transport.

Air or other fluid is selectively applied to the exit orifice 14 by operation of a trigger 27 pivotally mounted on the handle 11. The trigger 27 engages a spring-urged actuator rod 28 to open and close the valve 19. A knurled thumb nut 29 is mounted on a threaded portion of the rod 28 to vary the spring pressure on the trigger.

In use of the gun, the surface 13 of the head 12 is moved over a slice 10. The trigger 27 is depressed to apply pressurized fluid through the line 18, the coupling 17, the passageway 16, and then through the exit orifice 14, whereupon the air is laterally deflected and the slice is picked up. The pickup action results because the total pressure head on the top of the slice must be maintained constant in accordance with Bernoulli's theorem. More particularly, during pickup, the total pressure head on one planar surface of the slice facing the surface 13 comprises a velocity head plus a static head which is less than atmospheric pressure. On the other side of the slice there is a static head which is at atmospheric pressure, thus there is static pressure differential which is sufficient to act against and move the slice toward the surface 13. As the slice moves closer to the surface 13, the space or gap for the air escape decreases resulting in greater opposition to air flow. The opposition to air flow is accompanied by a decrease in the velocity head so that the slice moves toward the surface 13 until there is a balance between the total pressure heads acting on both surfaces of the slice. If the air pressure increases, there is a corresponding increase in the velocity head and as a consequence, reduction in the static head resulting in the atmospheric static head forcing the slice to move closer to the surface 13.

In the use of the gun, it is near impossible to center the exit orifice over the slice 10; thus, there will be more fluid passing over one section of the slice than over a diametrically opposed section. As a result, there is a force component tending to laterally shift the slice relative to the reference surface 13. Shifting of the slice 10 is limited by the lugs 25 with either the points 26 or the rounded ends 26'.

It may be appreciated that the surface of the slice 10 facing the reference surface 13 is not engaged during the holding of the slice in the suspended position. The slice 10 is supported at a distance from the reference surface 13 on a layer of flowing fluid so long as the pressurized fluid is applied to the passageway 16. The fluid impressed from source 24 may be ordinary air or it may be a special atmosphere which is utilized to treat the surface of the slice 10 exposed to the fluid. It is to be further understood that the fluid may be in the form of a liquid and the slice will be again held in the suspended position. In this instance, the fluid may have a detergent for cleaning the surface of the slice. Further, the liquid may be an etchant solution in which case the head 12 may be immersed in a tank of etching solution so that the top surface of the slice is rapidly etched and cleaned by the etchant flowing out of exit port 14. After the slice is treated with a liquid, it may be rapidly dried by applying heated air or other gaseous atmosphere through the gun.

Referring now to FIGS. 3 and 4, there is shown an alternative embodiment comprising a head 32 having a passageway 36 for receiving fluid passed through a coupling 37 connected to the gun shown in FIG. 1. In this instance, a circumferential array of passageways 38 are equally spaced about an exit orifice 34. A projecting rim 39 is formed about the entire periphery of the head 32 to prevent lateral shifting of a held slice 10.

In use of this embodiment, the fluid emanating from the exit orifice 34 laterally passes between the bottom surface of the head 32 and the top surface of the slice 10 and then passes through passageways 38. There is no lateral emission of fluid from the outer periphery of the head 32 thereby precluding the disturbance of other slices 10 that may be in the vicinity of the picked up slice.

Referring now to FIG. 5, an additional embodiment of the invention is disclosed comprising a gun 41 connected to a head 42 having a flat surface 43 in which there is formed an exit orifice 44 of an air pasageway 46. Passageway 46 terminates in a coupling 47 connected to a fluid line 48 running through a conventional valve 49 to a further air line 50 terminating in a bushing 51. The bushing 51 is connected to a conduit running to a source of pressurized fluid 52.

The head 42 is provided with a circumferential array of passageways 53 terminating at one end in the surface 43 and in the other end in a manifold 54. The manifold 54 communicates with a coupling 56 that is connected to a line 57 running to a valve 58 which is operated by the same trigger mechanism used to operate the valve 49. This trigger mechanism 59 is substantially the same as that shown in FIG. 1. The valve 58 is connected through a line 60 to a coupling 61 attached to a line 62 terminating in a vacuum pump 63.

The surface 43 is surrounded by a continuous projecting rim 64 similar to rim 39 (FIG. 4) which again limits lateral shifting of a slice 10 relative to the surface 43.

In operation of this embodiment, the trigger mechanism 59 is operated to open valves 49 and 58 whereupon pressurized fluid emanates from the exit port 44 to act on and hold a slice 10 suspended from the surface 43. The laterally moving fluid readily passes into the vacuum lines 53 and through the manifold 54 and thence through the line 57, the valve 58, and the line 59 to vacuum pump 63.

Referring to FIGS. 6 and 7, there is shown a further embodiment of the invention having facilities for limiting the lateral shifting of a held slice and for receiving and deflecting the laterally moving lifting fluid. In this embodiment, head 71 is again provided with an axial passageway 72. The head 71 is circular in shape and is provided with a plurality of radial fins 73 secured to the circumference of the head 71. Mounted on the ends of the fins 73 is a skirt or sheet-like ring 74. The lower portion 75 of fins 73 are wedge-shaped, similar to the lugs 26 or 26' shown in FIGS. 1 and 2. The skirt depends a predetermined distance below a reference surface 76 formed by the face of the head 71. Attached to, or formed integral with the end of the skirt 74, is an inwardly extending flange or lip 77.

In use of this embodiment, air is impressed through the passageway 72 and laterally flows across surface 76 to provide a reduced static head which acts on a slice 10 to lift and hold the slice in suspension. The slice 10 is held at a distance which is less than the distance the flange 77 is spaced from the surface 76 so that the laterally moving air is directed past the flange 77 into the space between the circumference of the head 71 and the skirt 74. Lateral shifting of the slice 10 is limited by the depending portion of the skirt 74.

It is to be understood that the above-described arrangements of apparatus and construction of elemental parts are simply illustrative of applications of the principles of the invention and many other modifications may be made without departing from the invention.

What is claimed is:

1. A pressurized fluid pickup device for lifting an article having a planar surface comprising,

handle means having a pair of fluid conduits running therethrough,

a head attached to said handle having a flat surface,

said head having a centrally disposed passageway in communication with a first of said fluid conduits and terminating in said flat surface,

said head having a group of passageways radially disposed about said central passageway in communication with a second of said fluid conduits and terminating in a group of radially disposed orifices in said flat surface,

means for applying pressurized fluid to said first fluid conduit,

means for applying vacuum to said second fluid conduit, and

valve controlled means for selectively applying said pressurized fluid from said first conduit through said central passageway to impinge on and flow across said planar surface of said article with sufficient velocity to impress a lifting force on said article in accordance with Bernoulli's theorem and for simultaneously applying vacuum to said radially disposed passageways through said second conduit to withdraw the fluid flowing across said flat surface.

2. In a device for lifting and holding a thin slice of material in suspension,

a circular head having an axial passageway therethrough terminating in an exit orifice formed in a planar end surface of said head,

a plurality of support fins projecting from said circumference of said head,

a ring skirt mounted on said fins to project beyond said planar end surface,

said ring skirt having an inwardly projecting flange that is spaced a predetermined distance from said planar surface, and

means for forcing air through said passageway against a slice of material to laterally deflect the air with sufficient velocity to lift and hold said slice at a distance which is less than said predetermined distance whereupon said laterally deflected air passes between said head and flange and then between said head and said ring skirt.

References Cited

UNITED STATES PATENTS

2,280,658	4/1942	Miller	294—64
3,223,443	12/1965	Misson	294—65

FOREIGN PATENTS

944,175	12/1963	Great Britain.

GERALD M. FORLENZA, Primary Examiner

G. F. ABRAHAM, Assistant Examiner